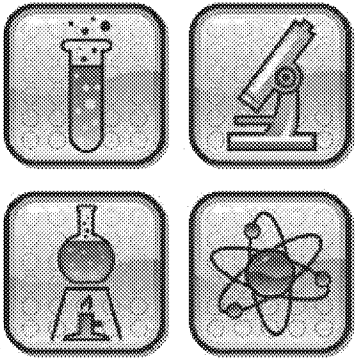

Refining Groundwater & Transport Understanding at the Navy Red Hill Facility

*Presented to:
Dr. Matt Becker & AOC Parties*

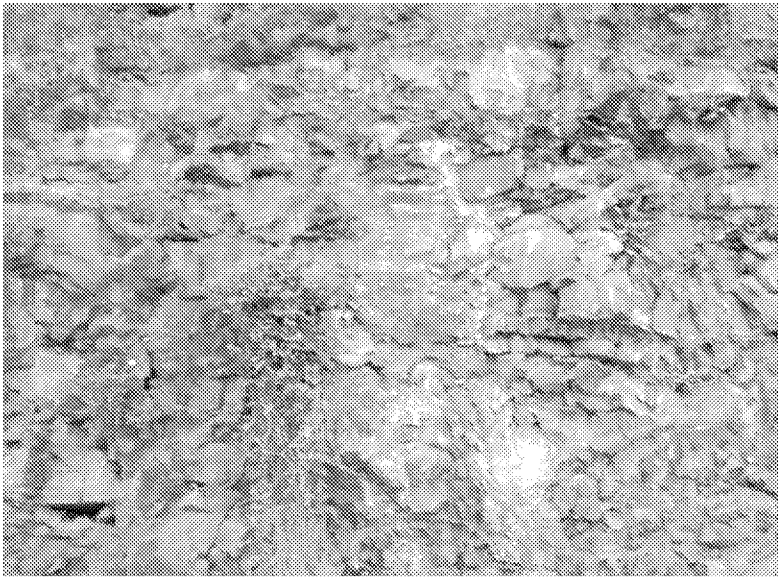
*April 28, 2021
G.D. Beckett, PG, CHG
AQUI-VER, INC.
SME for Hawaii Dept of Health*

Transport Observations by Others



- Pore scale processes are important
 - But won't often be seen at macro-scale
 - Homogenization can yield insights, but limited
- Heterogeneity **cannot** be modeled deterministically
 - Micro-scale phenomena appear semi-random
 - Stochastic approaches should be considered
 - *Abbreviated from Russell et al., NSF (2008)*
- Small volumes of LNAPL in fractures can produce significant LNAPL heads:
 - Significant depth of penetration into aquifer possible
 - Monitoring well observations are not straightforward
- The presence of potentially mobile LNAPL beneath historical groundwater surface lows should be considered
 - *Abbreviated from Hardisty et al., J. of Eng. Geo & Hydro 2003*

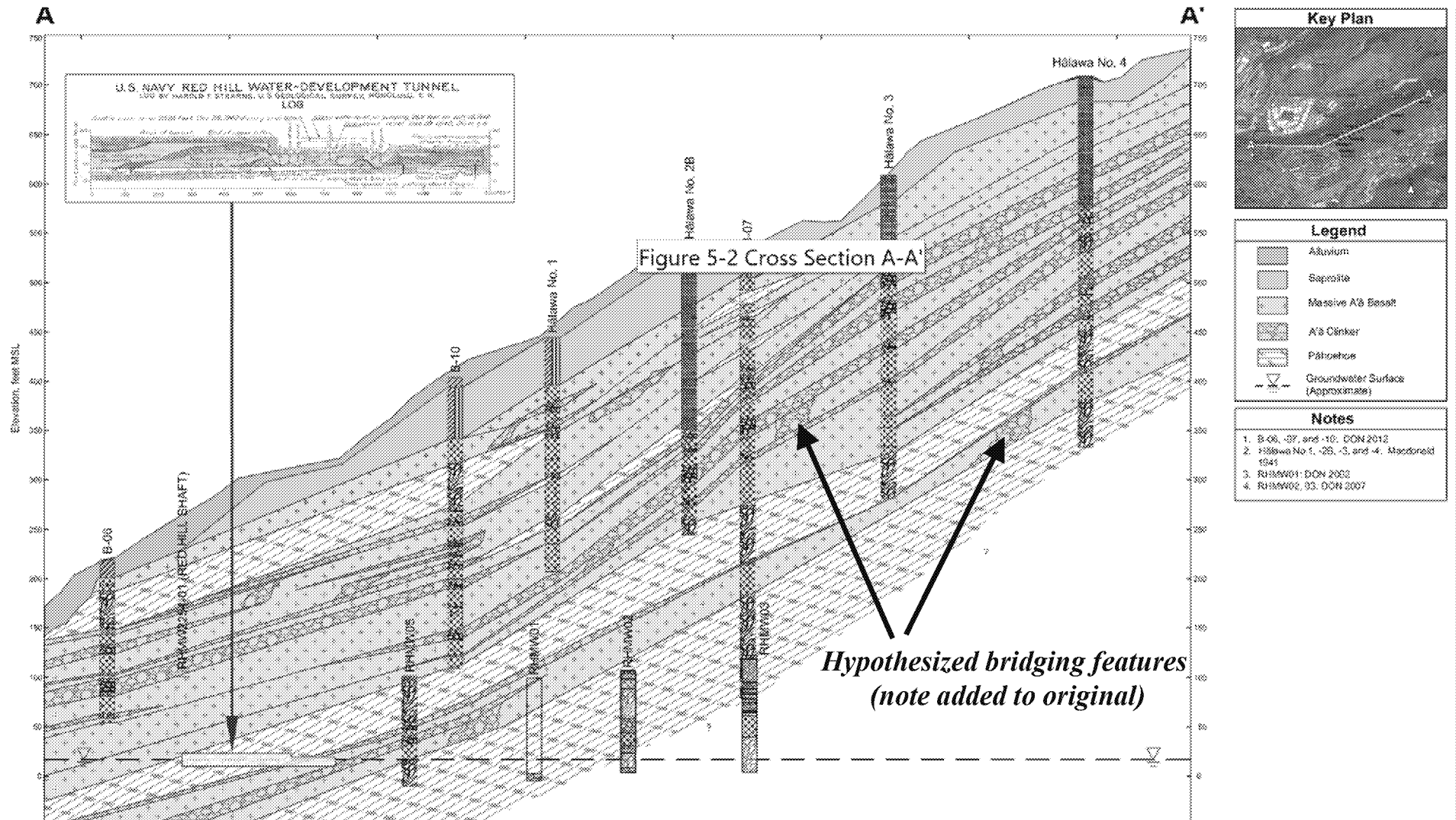
The Hawaii Hard Rock Release Experience



Source: Don Thomas, 2021

- Fuel releases often move quickly
 - Typically in complex pathways
 - Primary & secondary transport
 - Often difficult to characterize
- Fast-track geologic features exist
 - Lava tubes, voids, clinkers, others
 - Often sparse distribution, large effect
- Weathering of rock is complex
 - Non-uniform in time & location
 - Adds to transport complexity
 - Bulk rock properties may not apply
- For Red Hill
 - How is the architecture arranged?
 - How will fuel behave within that?
 - Effects on capture/remediation?
 - All relates to g.w. protection goals
 - And sole source aquifer preservation

Example Navy CSM Cross-Section



Source: Red Hill Conceptual Site Model Report, Rev 01, June 2019

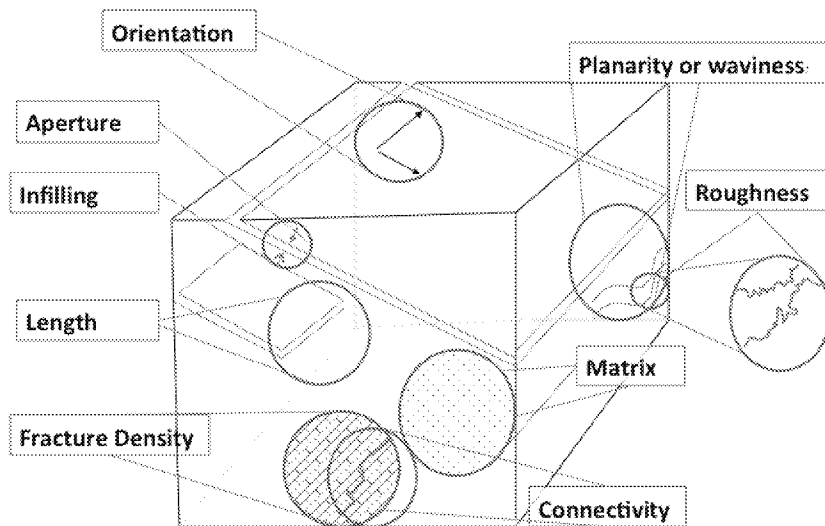
Example Factors Affecting Flow/Transport



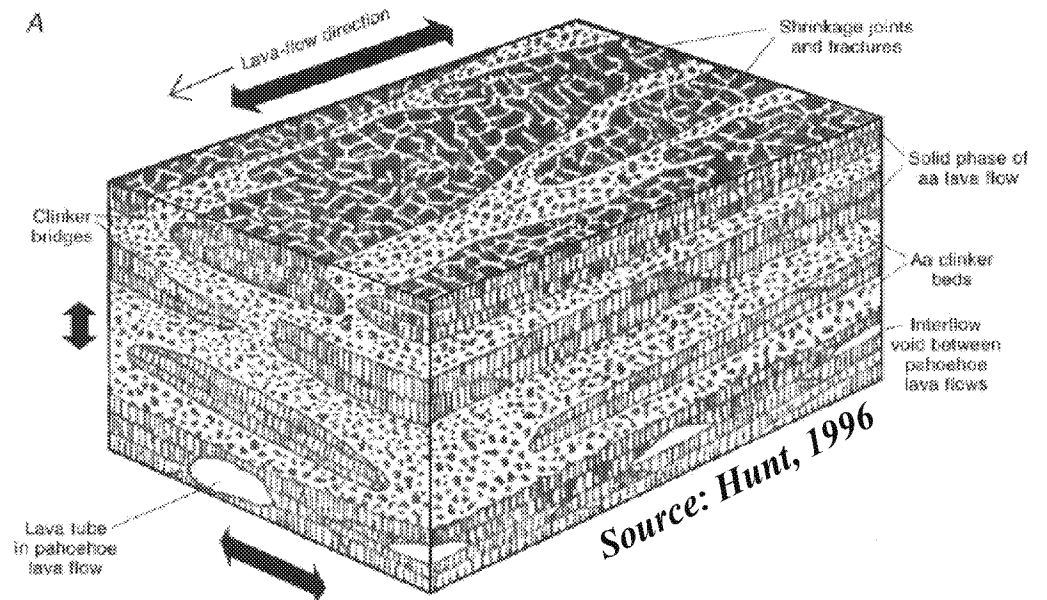
Source: Don Thomas, 2021



Source: Matt Tonkin, 2018

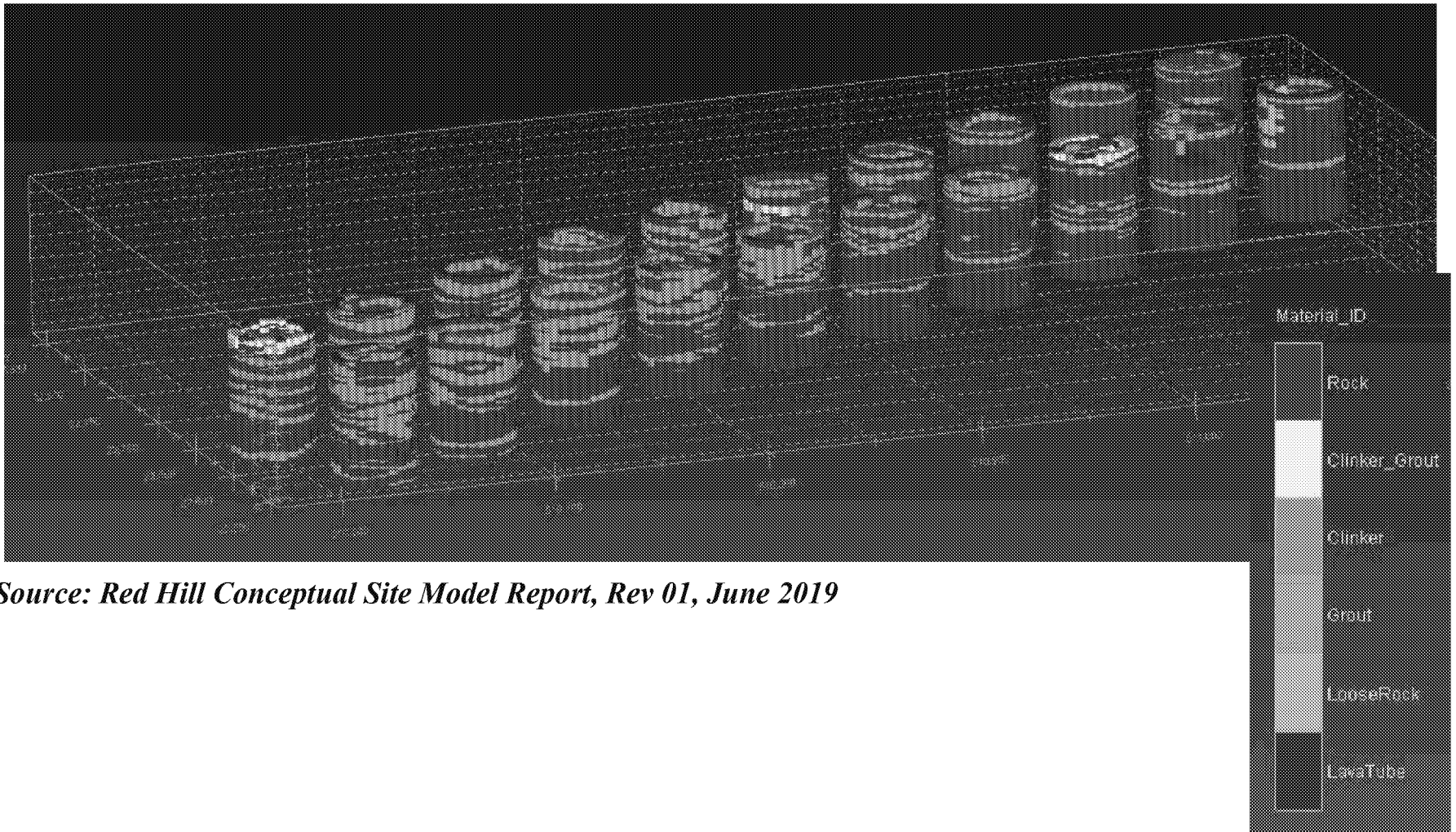


Source: ITRC, 2017



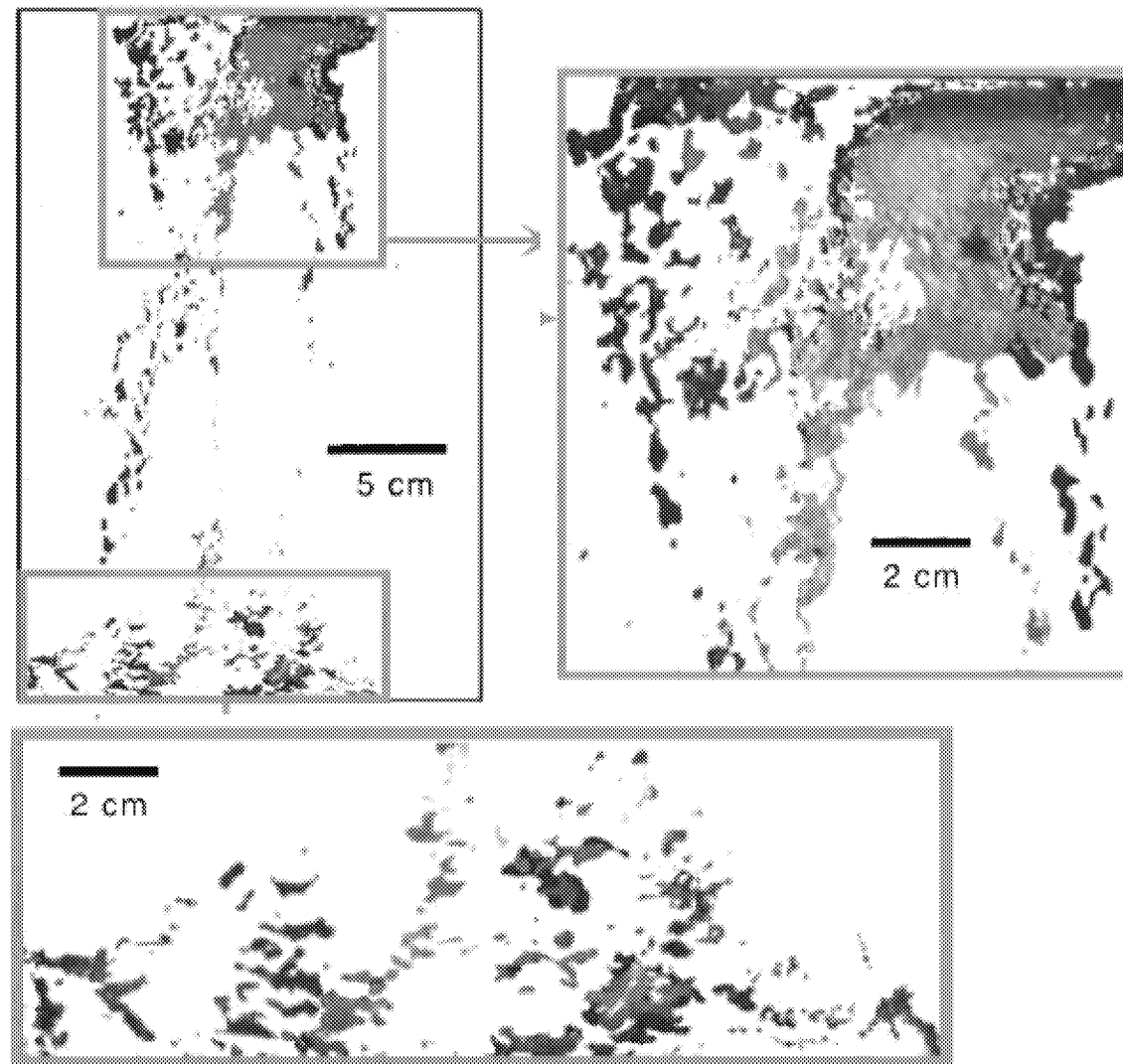
Source: Hunt, 1996

Navy 3D Lithologic Model – Barrel Logs



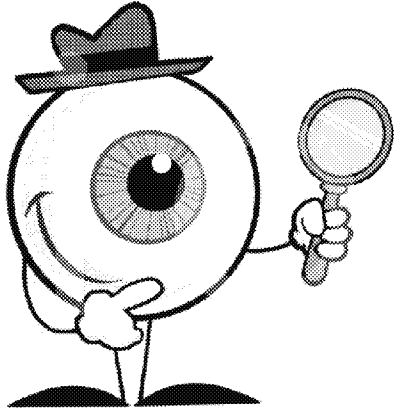
Source: Red Hill Conceptual Site Model Report, Rev 01, June 2019

Complex NAPL Distribution in a Fracture



Geller et al., 2000

The Basis for Further Investigations



- The DOH sees uncertainty in the CSM
 - With key complexities not characterized
 - Alignment of modeling approaches with data
 - Particularly NAPL/CF&T
 - And those effects on mitigation measures
- Key CSM elements need technical confirmation
 - Basics like g.w. flow directions and rates
 - Variance, if any, at the water table zone
 - Potential vertical dilution effects
 - Transport behavior elements
 - Dispersivity, compartmentalization
 - Potential dual-domain type responses
 - EPM scale dependency aspects
 - Particularly for NAPL transport
- Leading to sound approach to CF&T/risk
 - And aid in public communications